

MATERIALS TOXICITY CLEARANCE IN RN SUBMARINES

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In 1982, more than 150 items were presented to the Submarine Medicine Section at the Institute of Naval Medicine (INM) for materials toxicity clearance and subsequently entered in the Materials Toxicity Guide (MTG) which is held on computer file and reissued six monthly as an Annex to BR1326, Air Purification in Nuclear Submarines. The increasing demand for clearance coupled with the need to retrospectively examine many common place and traditional items already in service has resulted in the evolution of a formalised procedure. This consists of a series of progressive stages, not all of which are necessary in the majority of cases. The full procedure is described.

A request for clearance is submitted by design, maintenance and operational authorities to the Secretary of the Submarine Air Purification Committee of the Directorate General, Ships (DG Ships) who sponsors BR1326. While other aspects - material and fire - are referred to Admiralty Marine Technology Establishments (AMTE), the submission is forwarded to INM for toxicological assessment, with such information as is available, usually only manufacturers' data sheets. Additionally, information about the intended purpose of the material, usage (in build, refit, maintenance or at sea), frequency and duration of use, quantities required, available alternatives and an assessment of the penalties, if the material cannot be used, is provided on a proforma (A) from the source authority.

On receipt in INM, it is usually necessary to first write to the manufacturer requesting the product formulation which will be protected, Commercial-in-Confidence, and other relevant data which may be available or is specifically deemed necessary. Simultaneously an internal working form (B) is raised and completed as details are obtained.

Once the chemical composition of a product is known then each component is sought in a source reference such as Aldrich¹ from which initial information - molecular formula and some physical properties - is obtained; there may also be references to NIOSH 'RTECS'² and Sax³. Additional information may be sought in other texts such as Patty⁴. Furthermore some inference of toxicity may be drawn by analogy from the chemical formula and molecular structure.

If there is or is provided sufficient information or there is particular concern about safety, evidence of mutagenicity or suspected carcinogenicity or there is marked potential for exposure then a literature search is requested. The Defence Research Information Centre select a suitable agency to search appropriate files and subfiles; Toxline, Chemline, Cancerline and Medline usually suffice. HEEP or Health Effects of Environmental Pollutants is an example of a subfile of Toxline.

Other sources of advice may be requested to assist. If information on formulation is inadequate or lacking then AMTE will perform material analysis. The Toxicology Division of the Chemical Defence Establishment may conduct in vitro mutagenicity and animal studies. Information may be sought from the USN under IEP B52 auspices or the French Navy through the Anglo-French Information Exchange. The Ministry of Agriculture, Fishery and Food, the Health and Safety Executive (HSE) and large industrial concerns, particularly producers of chemicals and petroleum products, may also be able to provide specialised information.

With the data accumulated it should, at this stage, be possible to make a valued judgement about the acceptability of use in submarines. Where appropriate Maximum Permissible Concentrations (MPC) are set and will be established in respect of the most toxic components and principal products likely to be evolved. This may entail study of the chemical and physical properties to determine break down products, potential for evaporation and subsequent behaviour. In relation to vapour pressure and likely ambient temperature, maximal atmospheric concentrations can be predicted as can the minimum quantities which would need to be released to achieve such levels. Flash points, flammable limits in air and lower explosive limits must also be considered and may in some cases represent the limiting factors.

The MPC may be based on existing TLVs obtained from ACGIH⁵ or HSE⁶ and be modified by a factor of five to extrapolate to a "200 hour week" (the additional 32 hours compensating for loss of intervening periods of non-exposure between working days and weeks). Where TLVs have not been set or are considered inappropriate for submarine application the determination of MPCs might be based upon information derived from the literature and other sources or research; desired MPCs may also have to be realistically adjusted to take account of the degree of control practicably achievable provided that compatibility with health and performance is maintained. Carbon dioxide, carbon monoxide and Halon are particular examples.

When an EPC is set it must be decided whether that should solely represent a design criterion in terms of performance of air purification equipment, engineering containment or restriction on use or whether compliance should be monitored either retrospectively or in real time. If the latter is required and no suitable monitoring means is available then the necessary procurement is recommended. Currently no routine biological monitoring of RN submariners is conducted.

Guidance on safety and hygiene is necessary in some cases and may be derived from standard sources, ^{3,4,7,8} manufacturers' safety data sheets or compiled de novo from data gathered during investigation. In particular, handling precautions, physical and respiratory protection required and the management of spills, leakage or other excursions and personal contamination must be specified.

Finally whatever the outcome of the investigation, the material must be entered into the MTG. This requires assigning a material to a suitable category for which there are currently fourteen tables (Figure 1). Within that table it is given a serial number according to alphabetical positioning, named as an item, which may be starred* if considered especially hazardous, listed by Naval Store number or NP if non-patternised and, most importantly, is designated by class of item from one to five (Figure 2) which specifies its usage within the submarine. Class is normally determined by the potential contribution to the submarine atmospheric content (of pollutant) during prolonged shut down periods but may also take into account the fire characteristics if significant quantities of the material will be used or carried. The next column specifies the quantities which may be carried at sea unless the extremes of NC (not carried) or AS REQD (as required) are stated. Between these extremes, latitude may be granted by 'MINIMUM' or 'AS FITTED BY BUILDER'. The final, remarks, column contains brief notes on usage, conditions of ventilation required, particular hazards and precautions; more detailed guidance is provided through formal Service channels. A representative page is exemplified as Figure 3.

The recommended decision about a material is forwarded to DG SHIPS on a form (C) detailed in the format in which it will appear in the MTG when the recommendation is confirmed. This form is then returned to INM as authorisation to amend the MTG.

Currently the MTG applies only to nuclear submarines. However, the new design SSK, the '2400', will be designed and built to current MTG standards and proposed new materials for use in build will undergo the same scrutiny as if for nuclear submarines. To what extent stores carried by SSKs should be governed

by the MTG in its present form is under discussion. The restrictions imposed on nuclear submarines may be excessive for conventional operating conditions; accordingly it may be decided that a revised guide, incorporating sub columns (for nuclear and conventional) under both 'class' and 'quantity carried' columns, will be appropriate. The addition of a further column coding the pyrolysis product hazard in an analogous manner to toxicity class is also under consideration.

In conclusion, a comprehensive but flexible screening procedure exists to scrutinize each material proposed for use in nuclear submarines. The full procedure is required for only a minority of substances. The provision of the MTG and the screening procedure are being applied to the new design SSK and the MTG may be modified to accommodate conventional submarine requirements. The MTG may further be modified to include fire hazard assessment.

REFERENCES

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2. NIOSH. Registry of Toxic Effects of Chemical Substances. Ed. LEWIS R J and R L TATKEN. US Government Printing Office, Washington. 1980.
3. SAX, N I. Dangerous Properties of Industrial Materials. 5th Edition Van Nostrand Reinhold Company, New York. 1979.
4. PATTY, F A. Industrial Hygiene and Toxicology, Volume IIA Ed. CLAYTON G D and F E CLAYTON 3rd Edition. Wiley-Interscience, New York. 1981.
5. ACGIH. Threshold Limit Values for Chemical Substances and Physical Agents in the Work Environment with Intended Changes for 1982. ACGIH, Cincinnati. 1982.
6. HSE, TLV 1982 Guidance Note EH15/82 from the Health and Safety Executive. HMSO, London. 1982.
7. NIOSH/OSHA. Occupational Health Guidelines for Chemical Hazards. US Government Printing Office. 1981.
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CATEGORIES IN THE MATERIALS TOXICITY GUIDE (ER1326A)

<u>TABLE</u>	<u>CATEGORY</u>
1	ADHESIVES
2	JOINTING COMPOUNDS & SEALANTS
3	CLEANING AGENTS & DISINFECTANTS
4	DETERGENTS
5	INSULANTS
6	RUBBERS, PLASTICS & SYNTHETICS
7	OILS & GREASES
8	MEDICAL MATERIALS
9	PAINTS & VARNISHES
10	PESTICIDES & FUNGICIDES
11	PHOTOGRAPHIC MATERIALS
12	CHEMICALS
13	DOMESTIC MATERIALS
14	MISCELLANEOUS

Figure 1

MATERIAL CLASSIFICATION

<u>CLASS</u>	<u>INTERPRETATION</u>
1	PROHIBITED
2	CONSTRUCTION AND REFIT ONLY
3	MAINTENANCE AND DED (DOCKING AND ESSENTIAL DEFECTS)
4	RESTRICTED -- USE AT SEA UNDER SPECIAL CIRCUMSTANCES
5	PERMITTED -- CARRIED IN APPROVED QUANTITIES

Figure 2

TABLE 6 RUBBERS PLASTICS SYNTHETICS

Figure 3

S/N	ITEM	NS CAT NO	CLASS	QUANTITY CARRIED	REMARKS
1	ABS PLASTIC (CYCOLAC T)	NP	5	AS REQD	FITTINGS ON BATTERY AGITATION SYSTEM
2	ADC MK2 POLYURETHANE PARTS	NP	4	AS REQD	
3	ARNO TAPE (ADHESIVE BACKED NEOPRENE RUBBER)	NP	5		MADE BY ARNO ADHESIVES TAPES LTD. APPROVED FOR USE IN SMALL QUANTITY. NOT MORE THAN 1 CU FT TOTAL
4	BORON NITRIDE THYRISTORS	NP	5	AS REQD	USED IN SPE DEVELOPMENT
5	CARPET UNDERLAY. RUBBER OR FOAM	NP	2	NC	FURNISHING
6	CAST NYLON 6	NP	5	AS REQD	TEMPORARY COVERS FOR FURNITURE AND EQUIPMENT
7	CLOTH SILICON RUBBER COATED GLASS 0330/139-0530	NP	5	AS REQD	TYGLAS
8	DECLON	NP	5	AS REQD	VENT EXHAUST FILTERS
9	DELRIN	NP	5	AS REQD	AS REQD FOR 24 POSITION ROTARY WAVER SWITCHES ONLY
10	DINGHY REPAIR OUTFIT (*)	0472/2405	4	1 KIT	RESTRICTED USE ONLY WHEN IN OPENED UP CONDITION
11	ELF PLASTIC CAPS	CLASS GROUP 0269	5	AS REQD	
12	EPOXIDE RESIN UN45 LV	NP	4	Minimum	HAZARDOUS. FOR EMERGENCY USE ONLY. TO BE HELD BY ECO. PROTECTIVE CLOTHING AND RESPIRATORY PROTECTION REQUIRED.
13	EXPANDED POLYSTYRENE	NP	1	NC	USED FOR PACKING STORES
14	EXPANDED SYNTHETIC RUBBER	NP	3	NC	USED ON SSK MAIN GENERATOR RESILIENT BED
15	FABLON SELF ADHESIVE VINYL	NP	5	AS REQD	IN SHOWER SPACES TO IMPROVE WATERTIGHTNESS
16	FABULUX SUPERTREAD AND ARMOURTREAD	NP	2	AS REQD	VINYL FLOOR COVERING
17	FURMANITE FCE	NP	5	AS REQD	-
18	GILFLEX NORYL PLASTIC CONDUIT	NP	2	AS REQD	ONLY NORYL-POLYPHENYLENE OXIDE IS TO BE USED
19	LATEX FOAM MATTRESSES	NP	5	AS FITTED BY SHIPBUILDER	APPROVED FOR USE WHEN ENCASED IN RUBBERISED ASBESTOS COVER. OTHERWISE USE POLYETHER FOAM MATTRESSES
20	LEXAN 2000	NP	5	AS REQD	USED ON CENTRALISED CONTROL CONSOLE FACIA PANELS
21	LIMESTONE REINFORCED POLYPROPYLENE (LPPN 2960)	NP	5	AS REQD	USED ON TEMPERATURE MONITORING HEAD AMPLIFIER CASES
22	LINATEX	NP	4	APPROVED SPARES	FLEXIBLE RUBBER CONNECTIONS FOR VENTILATION TRUNKING